

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)
)
Expanding Flexible Use of the 3.7 to 4.2) GN Docket No. 18-122
GHz Band)

INTELSAT LICENSE LLC PETITION FOR RECONSIDERATION

Laura H. Phillips
Qiusi Y. Newcom
Faegre Drinker Biddle & Reath LLP
1500 K Street NW Suite 1100
Washington DC 20005
202-842-8800
laura.phillips@faegredrinker.com
Counsel for Intelsat License LLC

Michelle V. Bryan
Executive Vice President, General Counsel and Chief Administrative Officer
Susan H. Crandall
Associate General Counsel
Intelsat US LLC
7900 Tysons One Place
McLean, VA 22102-5972

May 26, 2020

EXECUTIVE SUMMARY

One of the guiding principles in this proceeding is that the repurposing of the lower portion of the C-band spectrum must unfold in a manner that ensures continuity for existing satellite services enjoyed by millions of Americans. However, there are several technical concerns regarding the Federal Communications Commission's (the "Commission") Report and Order that, if unaddressed, could both result in the loss of some existing satellite services and put satellite safety at risk. Either of these outcomes would fail to serve the public interest.

Intelsat License LLC ("Intelsat") understands the Commission did not purposefully intend to jeopardize a space station operator's ability to provide service continuity to customers or to adversely affect a space station operator's ability to command its satellites. However, the Report and Order fails to recognize the operational issues arising from the determination not to allow, on a protected basis, continued use of the full 500 MHz of the C-band at Intelsat's two consolidated Telemetry, Tracking, and Command ("TT&C")/Gateway sites, which will be located – per the criteria set forth by the Commission – at remote locations away from major population centers. These operational issues cannot be ignored because they will cause customer service disruption and endanger safe station-keeping of U.S.-licensed satellites controlled through Intelsat C-band teleports in the contiguous United States. On reconsideration, the Commission should reverse this decision.

Allowing continued protected use of the full 500 MHz at two remote TT&C/Gateway sites would also eliminate the need to design and install custom TT&C-specific filters that are subject to specifications currently set forth in the Report and Order that cannot, as a technical matter, be met. Intelsat provides along with this Petition expert analysis and findings from Alga Microwave explaining that no filter can be manufactured to function within the Commission's stated expectations. Rather, any workable filter would require a 20 MHz guard band on both sides of the TT&C carrier. Therefore, the Commission must either revise the filter specifications

for TT&C antennas to ensure their feasibility or, alternatively, accord protected status for use of 500 MHz at the two remote consolidated TT&C/gateway sites – thereby eliminating the need for a TT&C-specific filter.

Additionally, the Commission on reconsideration should revise the out-of-band protection requirements set forth in the Report and Order, which Intelsat believes will likely fail to adequately protect all earth stations from experiencing interference post-transition. Regardless of whether the agency revises such protections, however, the Commission must clarify that so long as Intelsat has taken all steps within its control, the company will not be held responsible for interference caused by terrestrial operations post-clearing. Statements in the Report and Order could be read to suggest that space station operators must guarantee the same or better end-to-end video service quality to earth station customers post-transition. While Intelsat will do everything within its control to provide the same or better service to its customers, it cannot be held responsible for any interference that earth stations may experience from new flexible use operations post-clearing. The Commission must clarify this critical point on reconsideration.

Intelsat also urges the Commission to move the TT&C/Gateway site consolidation deadline of December 5, 2021 out to 2023 because an eighteen-month consolidation window simply is not achievable given the many time and resource-intensive activities that are required. Adjusting this date will have no adverse effects on new flexible use licensees because the Partial Economic Areas that today host Intelsat's TT&C/Gateway operations are excluded from Phase I acceleration. As such, those existing TT&C/Gateway sites will have protected use of the full 500 MHz until the Phase II deadline in those areas and there is therefore no need for the TT&C/Gateway site consolidation to be completed two years earlier.

Finally, Intelsat highlights that the unprecedented and ongoing global pandemic could result in serious challenges to meeting every transition deadline. These could arise as a result of difficulty in accessing earth station sites for required filter installations, labor stoppages, or

vendor delays. These problems may cause transition delays completely outside of satellite operators' control. The Commission should expressly allow for a waiver process if it becomes impossible for satellite operators to meet the deadlines adopted in the Report and Order that did not take into consideration the unexpected COVID-19 shutdowns and related challenges to a massive project like accelerated transition.

One of the end goals of this proceeding is to ensure continuity of existing satellite services post-clearing. Intelsat urges the Commission to address the technical and operational concerns raised in this Petition that threaten to undermine that goal. Intelsat is committed to work with the Commission to address these fundamental concerns. Given the ambitious timing adopted for the clearing process, swift consideration of these matters is critical.

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INTELSAT PETITION FOR RECONSIDERATION

Intelsat License LLC (“Intelsat”)¹ files this Petition for Reconsideration (“Petition”) of the Federal Communications Commission’s (the “FCC” or “Commission”) Report and Order, pursuant to 47 C.F.R. § 1.429, to highlight technical problems that, if not addressed, could thwart the Commission’s goal of rapidly clearing 3.7 to 4.0 GHz for use by new flexible use licensees, while still ensuring existing satellite service continuity.² The Report and Order adopted a range of complex and interrelated processes to forge ahead with clearing a portion of the C-band on an accelerated timetable. This complexity, coupled with the obvious interdependency of timely actions from a wide range of stakeholders with disparate interests, puts a heavy burden on the Commission to ensure that its chosen framework is viable.

I. INTRODUCTION

Intelsat’s Petition focuses on several key areas of concern where the Commission must reexamine the judgements it rendered on technical standards. By limiting its Petition in this manner, Intelsat is not signaling its agreement with all of the other Commission determinations. Rather, Intelsat is drawing attention to the need for swift Commission action reconsidering several technical requirements that fail to ensure that satellite operators will be able to provide “substantially the same” service to existing users after the transition of 3.7 to 4.0 GHz to new

¹ Intelsat License LLC, an FCC satellite licensee, and its affiliated entity Intelsat US LLC, which provides operational services to Intelsat License LLC, are collectively referred to in this Petition as “Intelsat.”

² Expanding Flexible Use of the 3.7 to 4.2 GHz Band, *Report and Order & Order of Proposed Modification*, 35 FCC Rcd 2343, paras. 171, 194 (2020) [hereinafter “Report and Order”].

terrestrial uses in the contiguous United States (“CONUS”).

Circumstances have changed for the affected satellite operators since the Commission sought comments on its Notice of Proposed Rulemaking in July 2018.³ As the Commission failed to endorse the C-Band Alliance’s proposals, former members of the C-Band Alliance no longer expect to jointly serve the functions that they had contemplated to carry out under the proposed Market-Based Approach.⁴ The FCC’s determination to hold a public auction, to adopt a rules-based clearing process, and to change proposed technical terms have fundamentally altered the transition process. And while most of these changes affect the process of clearing spectrum and awarding licenses for new terrestrial uses, some of the changes are likely to affect the continued viability of satellite services post-clearing and must be reconsidered.

Specifically, several technical aspects of the Report and Order could be so fundamentally disruptive to the viability of the clearing framework that their implementation is likely to frustrate the FCC’s stated goal of ensuring existing satellite services continuity so as not to harm the millions of American that rely on those services. Given the Commission’s ambitious timing for the clearing process, swift reconsideration of these technical issues is critical.

II. THE TECHNICAL RULES FOR THE PROTECTION OF COMMERCIAL OPERATIONS AT TT&C/GATEWAY SITES MUST BE RECONSIDERED AND REVISED TO AVOID LIKELY HARMFUL INTERFERENCE TO INCUMBENT SERVICES AND TT&C CARRIERS POST-TRANSITION.

Throughout the course of this proceeding, Chairman Pai consistently reiterated four guiding principles underlying every Commission decision relating to the transitioning and repurposing of a significant swath of C-band spectrum. The fourth of these principles states that: “. . . [w]e must protect the services that are currently delivered using the C-band so they can

³ See generally Expanding Flexible Use of the 3.7 to 4.2 GHz Band, *Notice of Proposed Rulemaking*, 33 FCC Rcd 6915 (2018).

⁴ Each satellite operator will have their own considerations and decisions to make going forward based upon the FCC’s determinations in the Report and Order.

continue to be delivered to the American people.”⁵ To achieve that goal, he emphasized that the “transition plan for this band [] will ensure that the American people are able to receive C-band services in a continuous and uninterrupted manner. The item lays out a comprehensive and systematic transition process that will ensure that all incumbents are held harmless. . . .”⁶

Despite these assurances, the Report and Order effectively precludes Intelsat’s ability to ensure service continuity by failing to protect critical aspects of its operations. For example, the Commission determined that it would only permit Intelsat to operate communications carriers at two designated TT&C sites within the CONUS in the 3.7-4.0 GHz band on an *unprotected* basis after December 5, 2021.⁷ This lack of effective protection for satellite gateway operations -- specifically the rejection of protected access to the full 500 MHz of C-band spectrum at consolidated TT&C/Gateway sites -- if not reconsidered, will jeopardize Intelsat’s ability to provide service continuity to existing customers. Additionally, this failure to allow fully protected gateway operations at the TT&C/Gateway sites will jeopardize Intelsat’s ability safely to operate its satellites because, as explained below, the Commission’s adopted TT&C filter requirements are technically unachievable and thus are not capable of being implemented. Because among the Commission’s core goals in this proceeding is the ability for satellite operations to continue providing “substantially similar” services, the unintended consequences of these decisions must be reconsidered carefully. Specifically, the Commission should consider all relevant facts and important aspects of satellite technical operations and station-keeping.

The Administrative Procedure Act prohibits agency action, findings of facts or

⁵ Expanding Flexible Use of the 3.7 to 4.2 GHz Band, *Statement of Chairman Ajit Pai*, 1-2, <https://docs.fcc.gov/public/attachments/FCC-20-22A2.pdf>.

⁶ *Id.*

⁷ There was a very limited exception to this for certain types of incidental transmissions directed at earth stations outside of CONUS. Report and Order, paras. 134, 375, 381, Appendix A (amended 47 C.F.R. § 25.203(n)).

conclusions of law that are “arbitrary, capricious, [or] an abuse of discretion.”⁸ This can include situations when the agency fails to “articulate[] a rational connection between the facts found and the decision made.”⁹ While courts generally “accord deference to an agency’s interpretation of its own ambiguous regulation” for legal conclusions, the agency’s rulemaking factual findings must be at least supported by “substantial evidence,” meaning “more than a scintilla” of “relevant evidence as a reasonable mind might accept as adequate to support a conclusion.”¹⁰ Indeed, “[o]ne of the basic procedural requirements of administrative rulemaking is that an agency must give adequate reasons for its decisions.”¹¹

Here, the Commission appears to have failed to appreciate some critical technical aspects of satellite operations and, as a result, made assumptions that fail to reflect engineering and operational realities. These oversights resulted in determinations that warrant reconsideration. Specifically, the FCC failed to appreciate evidence in the record that protected access for all 500 MHz at consolidated TT&C/Gateway sites, which will be located – under criteria set forth by the Commission – at remote locations away from major population centers, is required to ensure continuity of services, including programming uplinked outside the United States that is distributed in CONUS.¹² Additionally, the Commission erred in assuming that imposing a very

⁸ 5 U.S.C. § 706(2)(A) (2018).

⁹ *Worldcall Int’l, Inc. v. Fed. Comm’n Comm’n*, 907 F.3d 810, 817 (5th Cir. 2018).

¹⁰ *Id.* at 817-18. The FCC has acknowledged in similar cases that it has a legal obligation to reconsider its action when its original order contains at least “a material error” or when the petitioner “raises new facts or changed circumstances not known or existing at the time of the petitioner’s last opportunity to present such matters.” *See, e.g.*, *Prometheus Radio Project and Mega-Philadelphia LLC, Letter*, 35 FCC Rcd 182, 2 (2020).

¹¹ *Montgomery Cnty. v. Fed. Comm’n Comm’n*, 863 F.3d 485, 491 (6th Cir. 2017) (citing *Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2125 (2016)).

¹² *See, e.g.*, C-Band Alliance Ex Parte Filing (Jan. 14, 2020), 8, <https://www.fcc.gov/ecfs/filing/10114901800539> (“These sites are critical not only because they house the antennas that ensure safe station-keeping of the satellites, but also because they serve as gateways (or ingest points) for a significant amount of customer services that **must** maintain access to the entire 500 MHz of the FSS C-band downlink band.”) (emphasis added).

narrow guard band around each individual telemetry carrier and implementing strict filtering criteria would allow consolidated TT&C/Gateway sites to safely control satellite operations. These are errors with potentially material negative consequences for continued satellite operations post-transition. On reconsideration, Intelsat respectfully requests that the FCC correct both errors by allowing Intelsat to continue use of the full 500 MHz of the C-band at its two consolidated, remotely located TT&C/Gateway sites on a protected basis.

A. The Report and Order Failed Adequately to Protect Existing Gateway Operations.

Currently, Intelsat has fifty-five customers on twelve international – i.e., non-North American arc¹³ -- satellites that downlink to earth stations in the contiguous forty-eight states. The Commission can confirm by consulting confidential data provided to it by satellite operators that these international satellites are more heavily utilized than are satellites in the North American arc, and as such, there is insufficient capacity in the upper 200 MHz in which to groom these customers.¹⁴ As a result, Intelsat’s original proposal to “clear” the lower 300 MHz always included the need – and assumed the ability – to continue downlinking Atlantic Ocean region and Pacific Ocean region services to its two consolidated sites on a protected basis.¹⁵ This

¹³ The “North American arc” for this purpose is the portion of the geostationary arc that is used primarily for the distribution of video and audio services to all fifty U.S. states. It consists of those orbital locations from 87° W.L. through 139° W.L. There are orbital locations outside of this arc that are visible to earth stations in some portion of the contiguous 48 states or to Alaska or Hawaii. This Petition refers to satellites at these non-North American arc locations as “international” satellites.

¹⁴ Intelsat provided confidential data to the FCC that demonstrates this circumstance. *See* Intelsat License LLC Ex Parte Filing (May 28, 2019), [https://ecfsapi.fcc.gov/file/10909028182184/Intelsat%20-%20May%2028%20Cover%20Letter%20for%20Response%20to%20Satellite%20Use%20of%20the%20C-Band%20\(DA%2019-278\).pdf](https://ecfsapi.fcc.gov/file/10909028182184/Intelsat%20-%20May%2028%20Cover%20Letter%20for%20Response%20to%20Satellite%20Use%20of%20the%20C-Band%20(DA%2019-278).pdf) and https://ecfsapi.fcc.gov/file/10909028182184/Appendix%20A_Redacted%20For%20Public%20Inspection.pdf.

¹⁵ The FCC authorized four total post-transition sites for both Intelsat and SES. If Intelsat and SES both use the Brewster, WA teleport, effectively there would be a total of three sites used for this purpose rather than four.

limited use of 500 MHz at its two future consolidated sites would allow Intelsat to maintain a variety of necessary functions, including downlinking services from satellites outside the North American arc that cannot be groomed to operate in only 200 MHz, as well as continuing to provide managed services that rely on CONUS gateway antennas, which in turn can help avoid disruption to existing customer services.¹⁶

The Report and Order rejected as unnecessary Intelsat's future use of the lower 300 MHz for these gateway operations, except on a non-protected basis, without much explanation. After mentioning Intelsat's position in passing, the Report and Order simply concludes that "[e]xtending interference protection to these operations . . . could effectively preclude terrestrial operations across a wide geographic area near each TT&C facility across the entire 3.7-4.0 band."¹⁷ This assertion cites no analysis or specific evidence to support it and also fails to consider the fact that, as required by the Commission, these sites will be in remote areas where they are least likely to significantly impair terrestrial operations. Any failure to provide interference protection to consolidated TT&C/gateway sites in the lower 300 MHz will almost certainly negatively affect the managed services Intelsat provides in its satellite network, as well as the international video programming services downlinked for cable network distribution in the United States.¹⁸ Thus, if this determination is not reconsidered, the Commission's goal that there be no loss of service post-transition likely will not be realized.

The Commission's only proffered reason for refusing to allow protected operations in all 500 MHz at Intelsat's two consolidated sites – that doing so would place too big a burden on

¹⁶ See C-Band Alliance Ex Parte Filing, 13 (Apr. 9, 2019), <https://ecfsapi.fcc.gov/file/10409183088602/CBA%20-%20Ex%20Parte%20re%20CBA%20Implementation%20Process.pdf>.

¹⁷ Report and Order, paras. 379-80.

¹⁸ See *supra* note 11.

future terrestrial operations – is not supported by the record.¹⁹ The criteria proposed by the satellite operators for selecting the future gateway sites, which the Report and Order adopted, were intended for the very purpose of ensuring that satellite operators select low-impact, remote sites that would be unlikely to cause significant impairment to future flexible use operations when maintaining protected use of the entire 3.7-4.2 band at those remote sites in order to maintain existing operations.²⁰ By adopting the criteria but not allowing these remote consolidated TT&C/Gateway sites protected access to the full C-band, the FCC appears to have failed to appreciate the significance of the designated TT&C/Gateway sites and critical nature of continued protected spectrum use to the satellite operators’ ability to deliver “substantially similar” services that are currently delivered using the C-band. On reconsideration, the Commission should allow use of the full 500 MHz on a protected basis for gateway operations at Intelsat’s two consolidated TT&C/Gateway sites in order to maintain and protect existing managed services and services downlinked from ocean-region satellites for CONUS distribution because maintaining these services plainly would be in the public interest.

Moreover, allowing use of the full 500 MHz on a protected basis at Intelsat’s two consolidated TT&C sites would solve a different, but equally troubling problem created by the Report and Order’s lack of effective protection of TT&C/Gateway carriers, as explained in Section B below. Use of the full 500 MHz on a protected basis at Intelsat’s TT&C/Gateway sites is of paramount importance to both maintaining existing services as well as ensuring safe station-keeping of the satellites.

¹⁹ See Report and Order, para. 380.

²⁰ See *id.*, para. 374; C-Band Alliance Ex Parte Filing (Jan. 14, 2020), 9.

B. The Filter Characteristics for Telemetry Carriers as Described in the Report and Order Are Physically and Technically Impossible to Achieve.

The Commission's technical rules establishing interference protection for TT&C/Gateway sites are designed to protect individual telemetry carriers by defining a narrow guard band around each carrier. This guard band would constitute the protected bandwidth of that telemetry carrier, and the Commission also required the implementation of a strict filtering parameter around these telemetry carriers to filter desired signals and to reject undesired signals. Specifically, the Report and Order requires that each TT&C/Gateway site install a custom-fit filter at the earth station facility that provides "a minimum of 60 dB of rejection."²¹ Further, "the filter should meet 60 dB of rejection for all frequencies removed from the TT&C's center frequency by more than 150% of the TT&C's emission bandwidth, both above and below the TT&C channel."²² The Report and Order also requires that this filter "provide 70 dB of rejection for all frequencies removed from the TT&C's center frequency by more than 250% of the TT&C's emission bandwidth, both above and below."²³

There is a problem, however, in that the Report and Order specified a filter that is outside the realm of what is physically and technically achievable. Without the ability to filter based on the physical circumstances of TT&C carriers used by Intelsat today, safe station-keeping of Intelsat's satellites, the majority of which are controlled by TT&C antennas located in CONUS, will be at great risk.²⁴ Indeed, reliable TT&C carriers are critical to ensuring the safety of not only Intelsat's fleet, but all satellites on the geostationary arc.

²¹ Report and Order, para. 389.

²² *See id.*

²³ *See id.*

²⁴ This should greatly concern the Commission because the United States is the administration of record under the United Nations Convention on Registration of Objects Launched into Outer Space for nearly all of Intelsat's fleet.

The physical and technical difficulty of the filter design relates to the size of the telemetry carriers, which clearly cannot be changed for satellites currently on orbit. Specifically, because Intelsat's telemetry carriers are narrow -- they have a 0.5 MHz nominal bandwidth -- the filter rejection specifications set in the Report and Order of 60 dB at 150% and 70 dB at 250% of the telemetry emission bandwidth from the TT&C's center frequency are technically infeasible. Indeed, any filter with such narrow bandwidth and high attenuation will generate multiple technical problems for the telemetry carrier, such as very high insertion loss, loss of frequency stability, and present form factor challenges.

Intelsat informed the Commission, prior to its adoption of the filter requirement, that in order to "achieve the 60 dB rejection at +/- 25 MHz from the center frequency," "the protected bandwidth around the telemetry signal must be at least 25 MHz from each TT&C band edge."²⁵ Intelsat further had pointed out that "[s]uch a guard band is necessary to ensure that the required passband filters do not add prohibitive insertion losses" and that "the 70 dB rejection criterion set forth in the Draft Order . . . is simply unachievable under the required insertion loss and group delay performance characteristics."²⁶ Nevertheless, with no contradictory evidence on this point in the record, the Commission characterized Intelsat's stated concern and the need for a broader guard band as "excessive" but failed to provide any explanation for reaching that conclusion.²⁷

Following Commission adoption of this filter requirement, Intelsat worked closely with an expert filter manufacturer -- Alga Microwave ("Alga")²⁸ -- to examine the filter

²⁵ Intelsat Ex Parte Filing (Feb. 21, 2020), 3, <https://ecfsapi.fcc.gov/file/102211247002419/Ex%20Parte%20Technical%20Meeting%20-%20Intelsat%2021%20Feb%202020.pdf>.

²⁶ *Id.*

²⁷ *See* Report and Order, para. 389.

²⁸ Alga Microwave, which was established in 2003, is a leading supplier of radio frequency ("RF") and microwave solid state power amplifiers, pulsed amplifier for radar applications, transmitter and transceiver products, as well as RF passive components and systems.

characteristics specified in the Report and Order. Significantly, Alga attempted to design a filter that meets these requirements while taking into account other performance requirements that are critical to the fidelity and integrity of the reception of telemetry signals.²⁹ As is the case with any technical design, there are many tradeoffs that must balance design objectives and performance metrics. After thorough analyses and simulations of options, Alga definitively concluded that it would not be possible to design a filter that would operate in the manner the Commission seems to have envisioned.³⁰ The Alga White Paper attached hereto details Alga's process and findings as well as the reasons why the filter design requirements adopted by the Commission are impossible to achieve.

The three key findings of the Alga White Paper are: (1) even with consistent use of a temperature stable material such as Invar, the center frequency can drift beyond the TT&C passband requirements; (2) tight manufacturing tolerances to achieve the FCC filter specification will result in a large frequency drift; and (3) to meet the rejection requirements and keeping insertion loss within a 1.0 dB, a guard band of 20 MHz on each side of the TT&C emission bandwidth (40 MHz total) is necessary in order to achieve 60 dB rejection.³¹ This would mean that each Intelsat TT&C carrier would need a 20 MHz guard band on both sides of the TT&C emission bandwidth (40 MHz total) in order to achieve the required 60 dB rejection specification.³² Thus, the required guard band would have to be orders of magnitude larger than the 0.5 MHz guard band that the Commission specified in its new rules in order for a TT&C emission

²⁹ Appendix A, Alga Microwave, *Feasibility Assessment of FCC's Narrowband C-band Filter Requirements* (May 22, 2020), 1 [hereinafter the "Alga White Paper"].

³⁰ *Id.* at 4 ("This paper demonstrates that a cavity filter cannot be designed to meet the FCC's recently adopted narrowband filter requirements to protect TT&C carriers from interference from co-channel flexible use operations").

³¹ *Id.* at 3-4.

³² *Id.* at 4.

bandwidth of 0.5 MHz to work.³³

Given these expert findings, more is required for the Commission to have engaged in reasoned decision-making on such a significant satellite safety matter. Because of the critical nature of maintaining reliable TT&C carriers to ensure safe station-keeping of Intelsat's satellites, it is imperative that the Commission review the study Intelsat provides on this matter and reconsider the TT&C guard band and filtering criteria set forth in the Report and Order.

Critically, were the Commission to reconsider its decision regarding gateway operations and allow those operations protected status in the lower 300 MHz at the designated TT&C/Gateway sites, as discussed above, then these TT&C specific filters would not be required. In other words, should the Commission decide to allow the protection of all 500 MHz at Intelsat's two remote TT&C/Gateway sites, there would be no new TT&C filter needed and thus, there would be no need for larger guard bands and the problem of establishing adequate and achievable filter criteria would not have to be solved.

III. THE FCC SHOULD STRENGTHEN ITS TECHNICAL RULES TO PROTECT EARTH STATIONS FROM HARMFUL OUT-OF-BAND EMISSIONS (“OOBE”) BUT, REGARDLESS, MUST CLARIFY THAT ITS POST-TRANSITION SERVICE STANDARDS DO NOT REQUIRE SATELLITE OPERATORS TO ADDRESS SERVICE QUALITY ISSUES OVER WHICH THEY HAVE NO CONTROL.

The Commission, in its *Emerging Technologies* spectrum proceedings, has historically demonstrated particular sensitivity to the potential for harmful interference to already existing services when authorizing the launch of new co-channel or adjacent channel operations. Chairman Pai expressly confirmed the Commission's stated commitment to maintaining the vibrancy of existing satellite and earth station services in his statement upon the adoption of the Report and Order.³⁴ This commitment, of course, would be rendered meaningless if the

³³ *Id.*

³⁴ See Expanding Flexible Use of the 3.7 to 4.2 GHz Band, *Statement of Chairman Ajit Pai*, 1-2.

technical parameters for co-existence of existing and new operations are not carefully calibrated to account for the reality of new and potentially harmful adjacent channel use so as to prevent instances of harmful interference.³⁵

After analyzing the Commission's framework for post-transition service standards, Intelsat has concluded that some incumbent earth stations, even with fully compliant filters installed, will inevitably experience harmful interference from the operations of new flexible use licensees. *This could occur even if the new flexible use licensees are operating within the technical parameters the Commission adopted for them.* This situation calls for careful reconsideration of the engineering assumptions underlying the Commission's requirements for new flexible use licensees so that existing satellite services will be protected post-transition. In the event the Commission does not reconsider these technical parameters, however, it must at the very least clarify that its post-transition service quality or comparability standards for earth station operators does not require the impossible from satellite operators. Having done everything within their control to ensure service quality, satellite operators cannot control for or overcome any harmful interference that incumbent earth station operators may experience as a result of the initiation of compliant operations of new 5G overlay licensees.

A. The Commission's Adopted Framework Failed to Confer Sufficient Protection on Post-Transition Earth Station Operations.

Prior to the Commission rejecting its Market-Based Approach proposal, the C-Band Alliance spent significant time and effort to develop and present to the Commission a comprehensive and responsible set of technical and engineering specifications that would permit the deployment of new flexible use services in the transitioned spectrum without harming earth stations' ability to receive satellite signals post-transition. These specifications not only included

³⁵ While Intelsat appreciates that the Report and Order envisions a working group of stakeholders to investigate and resolve interference complaints when they arise, that forum cannot substitute for operational criteria designed to ensure interference does not occur in the first instance.

an earth station filter designed to protect satellite customers in the remaining 200 MHz post-transition, but also addressed necessary technical design parameters for new flexible use licensees to ensure they would not harm these remaining satellite operations. These specifications were shared with the Commission and were subject to review and public comment. The integrated technical solution – the filter design as well as proposed power and OOB levels -- was developed to ensure, with a high degree of confidence, that future 5G overlay operations, once deployed, would not adversely affect earth stations in their receipt of usable satellite signals.

The Commission rejected the engineering and technical concerns that lead to this integrated design solution. The Report and Order determined instead that “the protection mechanisms we adopt herein will ensure that the potential for harmful interference to incumbent FSS earth stations is minimized regardless of the base station power levels permitted in the band.”³⁶ The Commission deemed it important to harmonize technical rules for new C-band licensees with those that apply to other mobile broadband services and expressed confidence that the fully integrated technical solution the C-Band Alliance developed and proposed was unnecessary, “excessive,” and “unduly complex.”³⁷

While Intelsat recognizes the value of harmonization of mobile service standards across bands where it is technically feasible, the policy instinct to promote harmonization at the expense of demonstrable, predictable interference to earth station operations, even after those earth stations have transitioned and are equipped with new filters, is not reasonable. Moreover, any policy preference for harmonization cannot substitute for careful and reasoned engineering assessment of the effects of the Commission’s determination to jettison important terrestrial

³⁶ Report and Order, para. 337.

³⁷ *Id.*, para. 389.

service operational requirements designed to protect earth station operators from experiencing harmful interference.

The Commission's decision to adopt some – but not most – of the C-Band Alliance's proposed technical standards could have material negative consequences for the post-transition interference environment. The Commission does not appear to have fully considered that satellite operators will be transmitting post-transition at the same power levels as before the transition, consistent with their contractual obligations to their customers. However, new flexible use licensees will deploy base stations that will be operating near earth stations that have installed filters. While the Commission has placed significant faith in the use of earth station filters as a primary means to protect the continued integrity of earth station operations, the ability of these earth stations to receive satellite signals reliably post-transition will also heavily depend upon the nature of the flexible use licensees' base station operations.

Intelsat is concerned that the OOB limits for new overlay licensees adopted by the Commission may leave many earth stations unprotected and subject to harmful interference, despite the fact that base stations causing interference will be operating within the technical rules as defined by the Commission and, thus, flexible use licensees presumably could claim they have no obligation to remedy such interference. There are several reasons for Intelsat's post-transition interference concern.

First, notwithstanding that the Commission adopted an I/N of -6 dB as the protection criteria to be accorded to incumbent earth stations from flexible use licensees, the Power Flux Density ("PFD") level adopted by the Commission was based on an assumed elevation angle of

19 degrees.³⁸ This corresponds to an off-axis gain of 0 dBi.³⁹ Given that C-band satellites in North American arc serving the contiguous 48 states occupy an arc that stretches from as far west as 139° W.L. to as far east as 87° W.L., many earth stations will have elevation angles much lower than 19 degrees. For example, an earth station located in Boston, Massachusetts and pointed towards a satellite positioned at 139° W.L. will have an elevation angle of only 7.6 degrees, while an earth station located in Portland, Maine and pointed towards the same orbital position will have an elevation angle of only 6.7 degrees. Accordingly, the Commission's assumed 19-degree elevation angle fails to consider or address, and likely will not protect, earth stations such as these from experiencing harmful interference.

Second, the Commission did not impose any antenna height limits on flexible use base stations. This further increases the likelihood that the angle of incidence in many cases will be lower than the 19 degrees assumed by the Commission's analysis. In such cases, the affected earth stations will fall outside of the PFD protection envelope defined by the Commission and the consequences of that on their operations may be severe. While Intelsat commends the Commission's decision to allow full-band, full-arc protection, the OOB rules, if not reconsidered, appear to leave many earth stations unprotected and with no apparent recourse for interference to be remedied once flexible use licensees begin deployment. This is because any flexible use licensee presumably would be able to show that it is operating in compliance with the FCC's rules, and without additional requirements to remediate harmful interference, earth stations may be without prompt or effective recourse.⁴⁰

³⁸ *Id.*, para. 363. Technically, the angle of incidence off-boresight is the key parameter rather than the elevation angle. However, when the FSS and 5G base station are at the same height, the angle of incidence off-boresight becomes the elevation angle. For simplicity, the term "elevation angle" is used in this Petition.

³⁹ This is based on the FCC antenna mask contained in §25.209(1). The gain is equal to 0 when the off-axis angle is ~19 degrees.

⁴⁰ The Report and Order encourages the industry, among other things, "to convene a group of

To demonstrate the potential interference problem, the following table compares the effects of the Commission’s adopted OOB standards on the I/N value for earth stations that have varying elevation angles.⁴¹ The first case presents a nominal 19-degree elevation angle, which corresponds to 0 dBi off-axis gain. The second case reflects an earth station with 10-degree elevation, and the third case reflects an earth station with 6-degree elevation. As noted above, all of these earth station elevation angle cases are present within the North American arc.

	Case 1: 19 degree Elevation	Case 2: 10 degree Elevation	Case 3: 6 degree Elevation
Flexible use pfd (dBW/MHz/m ²)	-120	-120	-120
Antenna noise floor (dBm/MHz)	-117.1	-117.1	-117.1
Antenna off-axis gain (dBi)	0	7	12.5
Filter Loss (dB)	0.4	0.4	0.4
I/N (dB)	-6.0	1.0	6.5
C/N Loss (dB)	1	3.5	7.4

This analysis shows that while holding all other variables constant, the -6 dB I/N criteria established by the Commission for protection of earth stations will be breached in many instances. While it may be the case that some earth stations with elevation angles below 19 degrees could have manmade or natural obstructions that may help to block emissions from nearby base stations, it is plain that there will be cases where certain earth stations will experience harmful interference caused by base stations. This will occur even though both the earth station and the flexible use base station are operating in compliance with the technical rules

interested stakeholders to develop a framework for interference prevention, detection, mitigation, and enforcement in the 3.7-4.2 GHz band” and to “consider best practices and procedures to address issues that may arise during the various phases of the C-band transition.” *See* Report and Order, paras. 333-34. Presumably that might include best practices and procedures for reporting and remediating instances of interference to earth stations from new service providers.

⁴¹ The Table assumes -120 dBm/MHz/m², which excludes the additional 4 dB for aggregate as reflected in the Report and Order.

as specified by the Commission in the Report and Order. Because that result cannot be what the Commission intended, this situation must be addressed on reconsideration to avoid more difficult or even intractable problems later.

The Commission has in the past adopted technical rules for new services that failed adequately to consider the interaction of these new services with existing services and that caused harmful interference. One example that is similar, in that there were unintended consequences of introducing new and incompatible operations in spectrum adjacent to existing operations, is that of digital 800 MHz commercial interference to public safety operations. Because each licensee was operating consistent with Commission rules, there was no simple way to remedy the issue, despite the serious nature of the interference received by the incumbent public safety radio operators.⁴² While the new entrant, Nextel, eventually put forward a proposal to alleviate the interference through the massive nationwide relocation of its operations and those of public safety licensees so as to spectrally separate its operations, the time from the initiation of the FCC proceeding in 2002 to consider the problem until the near conclusion of the relocation process was well over eighteen years. Billions of dollars were spent in this process that instead might have gone towards improving existing services or deploying new services, rather than fixing an unfortunate problem that the Commission failed to predict. This type of situation should be assiduously avoided when there is credible record evidence that specified interference protections will be inadequate.

In order to avoid the potential of painful dislocation or expensive after-the-fact fixes, Intelsat recommends that the FCC reconsider the OOB protection requirements and instead adopt either of the following possible solutions. First, the Commission could change the -124

⁴² See, e.g., Improving Public Safety Communications in the 800 MHz Band, *Report and Order, 5th Report and Order, 4th Mem. Opinion and Order, and Order*, 19 FCC Rcd. 14969, paras. 13-14 (2004).

dBW/ MHz/ m² OOB protection (elevation angle 19 deg) to -134 dBW/ /MHz/ m² (elevation angle 6 deg) to account for low elevation angle interference.⁴³ The Commission previously had rejected Intelsat’s proposal on this point because it incorrectly assumed that a lower OOB threshold would lead to “inefficient spectrum use.”⁴⁴ Another possible solution, as suggested by AT&T, is coordination if the elevation angle (technically the off-axis angle between FSS and 5G base station) is less than 19 degrees.⁴⁵ One form of this coordination could be to utilize the more stringent PFD calculation that the C-Band Alliance endorsed.

B. Any Post-Transition Interference Caused by Flexible Use Deployment Cannot be Addressed or Solved by Space Station Operators.

Regardless of whether the FCC modifies its technical rules for OOB and power levels on new flexible use licensees, the FCC must take a common-sense approach when evaluating pre- and post-transition comparability of services that space station operators are to provide to their customers and those customers’ affiliated earth stations. In connection with the discussion of earth station relocation costs, the Report and Order contains a statement about post-transition comparability, namely, that incumbent space station operators should “continue to be able to provide substantially the same or better service to incumbent earth station operators, and that incumbent earth station operators continue to be able to provide substantially the same service to

⁴³ Intelsat Ex Parte Filing (Feb. 21, 2020), 3-4.

⁴⁴ See Report and Order, para. 362.

⁴⁵ AT&T Ex Parte Filing (Oct. 22, 2019), <https://ecfsapi.fcc.gov/file/10222782926637/2019-10-22%20ATT%20C-band%20Tech%20Ex%20Parte%20-%20FINAL%20wExA.pdf> (“Specifically, AT&T recommends adopting a PFD limit of -124 dBW/m²/MHz for 5G operations in the 50 megahertz immediately below the FSS band edge. AT&T’s recommended limit assumes an off-axis angle of 20° or more, which AT&T believes should cover over 90% of the 5G to FSS earth station situations. Because earth station look angles approaching the 5° that CBA has suggested as relevant are largely limited to northern latitudes, in the rare cases where off-axis angles are below 20°, more stringent PFDs can easily be calculated. In creating a PFD methodology, the Commission could also set regulatory expectations regarding out-of-band emissions (“OOB”) limits. Although not strictly required to calculate PFDs from a specified PSD, establishing OOB limits will mitigate the variables associated with determination of the PFD and simplify that calculation.”) (footnotes omitted).

their customers after the relocation compared to what they were able to provide before.”⁴⁶ An accompanying footnote provides a further gloss on this: “We further clarify that comparability for video distribution services requires that the video quality of the end-to-end, programmer-to-viewer chain is at least as good as it is today.”⁴⁷

It is certainly Intelsat’s intention to provide the same or better satellite service to its customers’ affiliated earth stations post-transition, in conformance with its contractual obligations. However, the Commission at the very least must clarify that space station operators can only logically have a comparability obligation to address any signal degradation issue over which they can control.

Assuming the satellite operators have provided their contractually obligated service quality and installed filters as mandated by the Commission, any interference experienced post-transition with the rollout of new 5G overlay licensed operations near incumbent earth stations cannot be considered within the scope of the ability of space station operators to control or to address. *This is plain because satellite operators will have no ability to “fix” any interference that is coming from other licensees.*⁴⁸ Any earth station operator-to-viewer chain of video quality reception that is compromised solely by the operations of 5G licensees cannot be remedied by a change to satellite operations. It is important that the Commission clarify now

⁴⁶ Report and Order, para. 194.

⁴⁷ *Id.*, para. 194, fn. 518.

⁴⁸ The FCC in its *Emerging Technologies* framework consistently has put the onus on new entrants to ensure that existing operators (and their customers or users) continue to enjoy comparable services, which is the framework that should be used in this case. *See, e.g.*, Amendment of the Commission’s Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1775-1780 MHz, and 2155-2180 MHz, *Report and Order*, 29 FCC Rcd. 4610, para. 194 (2014) (relocation proceeding involving AWS and BRS licensees); County of Genesee, New York, *Mem. Opinion & Order*, 26 FCC Rcd. 12772, para. 7 (2011) (800 MHz rebanding proceeding); Amendment of Section 2.106 of the Commission’s Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service), *2d Report & Order & 2d. Mem. Opinion & Order*, 15 FCC Rcd. 12315, para. 92 (2000) (relocation proceeding involving MSS and FS licensees).

that that it does not intend to hold space station operators responsible for a comparability obligation that would be impossible for them to address or to satisfy.

Specifically, the Commission should clarify that space station operators need only demonstrate by their transition certifications that they have cleared the required amount of spectrum of satellite signals received in the contiguous 48 states and have taken all the steps *within their control* to ensure that earth station operators continue to receive C-band satellite service of the same or better quality as before the transition. The Commission should further clarify that if any subsequent post-transition issues arise as a result of terrestrial-based interference, that interference should be remediated, if necessary, by the flexible use licensees, as is the case generally in other *Emerging Technologies* new entrant situations, or by a subsequent revisiting of the efficacy of the terrestrial OOB requirements adopted in the Report and Order.

IV. THE DECEMBER 5, 2021 TT&C/GATEWAY SITE CONSOLIDATION DEADLINE IS UNACHIEVABLE AS A PRACTICAL MATTER AND SHOULD BE CHANGED TO DECEMBER 5, 2023.

The Report and Order requires that space station operators consolidate all TT&C/Gateway earth station links by the Phase I deadline of December 5, 2021.⁴⁹ While this date represents the endpoint for the eighteen-month deadline for Phase I of the accelerated relocation schedule, it is neither a reasonable nor adequate amount of time to accomplish all the tasks required to allow for the consolidation of all TT&C/Gateway sites. On this point, the FCC appears to have conflated the process of clearing 120 MHz of spectrum of FSS services in forty-six of the top fifty Partial Economic Areas (“PEAs”) and filtering associated earth stations, with the different process of consolidating Intelsat’s TT&C/Gateway sites.

Intelsat proposed to clear an “early tranche” of 100 MHz plus a 20 MHz guard band in

⁴⁹ See Report and Order, para. 375, Appendix A (amended 47 C.F.R. § 27.1412).

forty-six of the top fifty PEAs.⁵⁰ The ability to undertake that clearing within eighteen months was dependent on an explicit carve-out of certain designated PEAs, such as the Denver, Baltimore-Washington, and Atlanta PEAs, from this “early tranche.”⁵¹ This was because moving antennas and operations could not feasibly be completed in time to meet the “early tranche” deadline due to Intelsat’s substantial C-band teleport operations – both commercial and TT&C -- in those particular regions. Despite acknowledging these matters twice in the Report and Order, the Commission, without any specific discussion, determined that space station operators such as Intelsat would be required to do all that was necessary to consolidate TT&C sites within the eighteen-month Phase I deadline.⁵²

The amount of planning and work necessary to achieve teleport consolidation to make TT&C site consolidation possible is substantial. Intelsat will be required to purchase a new or existing facility, contract with one or more third-party teleport operators, upgrade the core infrastructure at both facilities (power, cooling, etc.), build more than twenty large antennas and pads at each of two new sites, and test all the new antennas to ensure that the satellites can be controlled effectively. Intelsat builds new antennas routinely as part of its core business and understands the amount of time and effort involved. For context, building a single large antenna such as the ones needed for TT&C typically takes nine to eighteen months, and that is on a site

⁵⁰ See *id.*, para. 35, fn. 110 (citing various filings from C-Band Alliance with specific emphasis on exclusion of designated PEAs from the “early tranche”).

⁵¹ See C-Band Alliance Ex Parte Filing (June 12, 2019), 8, <https://ecfsapi.fcc.gov/file/1061231991411/CBA%20-%20Auctionomics%20white%20paper%20ex%20parte%206.12.2019.pdf>; C-Band Alliance Ex Parte Filing (June 10, 2019), 17, <https://ecfsapi.fcc.gov/file/106102490907232/CBA%20-%20FUEL%20ex%20parte%206-10-19.pdf>; C-Band Alliance Ex Parte Filing (Apr. 9, 2019), 12.

⁵² See Report and Order, para. 157, fn. 432 (“This tranche excludes the Baltimore-Washington, Atlanta, and Denver PEAs . . . due to the need to protect Telemetry, Tracking, and Command (TT&C) sites . . . ”); para. 171, fn. 466 (excluding Baltimore-Washington, Atlanta, and Denver PEAs from the Phase I accelerated relocation deadline and noting that “the PEAs have been chosen with the TT&C locations in mind”).

that already has enough power, cooling, and land to host the antenna. Consolidating well over twenty antennas to new facilities is exponentially more complex and will likely take three years or more to complete. In contrast, the Commission had no record on which to base its determination that eighteen months was a sufficient time for the consolidation of all TT&C sites.

Additionally, this unexplained and overly aggressive consolidation deadline appears inconsistent with the rest of the Report and Order, which excludes the PEAs identified above from Phase I of the acceleration relocation schedule. By its own terms, the Report and Order allows the continued protected operation in all 500 MHz in the three PEAs in which Intelsat currently operates CONUS TT&C teleports -- Denver, Baltimore-Washington, and Atlanta -- at least until the end of Phase II in December of 2023. This is further evidence that the Commission conflated the two processes and may have reflexively adopted December 5, 2021 as the TT&C consolidation deadline without separately considering whether there was a specific reason dictating that as an appropriate or achievable date. Indeed, the Report and Order does not establish that adopting an unachievably early TT&C consolidation deadline would benefit the Commission, the future flexible use licensees, or the American taxpayers. Nor would any substantial negative effects on new 5G service deployment flow from changing this date to one that is workable. For these reasons, Intelsat urges the FCC to reconsider its decision to set a December 5, 2021 deadline to consolidate TT&C sites and to instead allow space station operators until December 5, 2023 to perform the significant work that will be necessary to consolidate TT&C sites to two designated locations.

V. THE COVID-19 PANDEMIC AND RELATED PUBLIC SAFETY ORDERS, SUPPLY CHAIN, LABOR OR OTHER CHALLENGES MAY REQUIRE THE USE OF TEMPORARY WAIVERS.

Finally, it should not be a surprise that project planning processes inevitably may be affected by the public safety orders affecting labor and site access given the unprecedented and ongoing serious public health emergency caused by the 2019 novel coronavirus (“COVID-19”)

global pandemic.⁵³ Intelsat is not disputing the Commission’s findings that having transition plan deadlines are important to the process and are “in the public interest” and “strike[] a fair and appropriate balance . . . to . . . ensur[e] space station operators, earth station operators, and other stakeholders have the necessary time to complete this transition in a careful, fair, and cost-effective manner” under ordinary circumstances.⁵⁴ Nevertheless, COVID-19 is significantly changing the state of domestic and international supply chains, the availability of site access and specialized labor for many parties involved in ensuring a timely transition process.⁵⁵

As a result of these new uncertainties, space station operators should not be penalized for COVID-19 delays that are beyond their control and that were not contemplated by the Commission at the time of the Report and Order’s adoption.⁵⁶ This unprecedented situation calls for further clarification from the Commission that space station operators may seek waivers if that becomes necessary and continue to be reimbursed for work performed under any opt-in to the acceleration process, despite COVID-19-related delays.

Intelsat is aware of and has brought to the Commission’s attention the potential for unexpected or unplanned work stoppages from vendors who will be key to moving the transition forward.⁵⁷ Local, state or regional COVID-19-related safety orders have slowed or ceased many aspects of operations that are deemed “non-essential” under relevant laws. This could, as an

⁵³ See Report and Order, para. 168, Appendix A (amending 47 C.F.R. § 27.1412).

⁵⁴ *Id.*, para. 160.

⁵⁵ See also NCTA – The Internet and Television Association Ex Parte Filing (Apr. 30, 2020), 1, <https://ecfsapi.fcc.gov/file/10430211724434/043020%2018-122%20NCTA%203.7-4.2%20GHz%20transition%20reimbursement%20ex%20parte%20FINAL.pdf>

⁵⁶ See Report and Order, paras. 174-75 (“If a space station operator fails to satisfy either the Phase I or Phase II deadline, it will not be eligible for the portion of the accelerated relocation payment attributable to the deadline that it missed” . . . “and will also be subject to penalties for their failure to timely clear”).

⁵⁷ See Intelsat Ex Parte Filing (Mar. 26, 2020), 3, <https://ecfsapi.fcc.gov/file/1032649679223/Ex%20Parte%20Meeting%20-%20Intelsat%2026%20Mar%202020.PDF>.

example, increase the difficulty of accessing for an extended period of time some earth station sites to perform required filter installations. These COVID-19-related challenges could also result in vendor delays due to shortfalls in the supply chain, and other problems outside of satellite operators' control. Meanwhile, satellite operators cannot now accurately anticipate whether and to what extent material issues may present themselves that would create impediments to meeting relevant relocation deadlines and, thus, cannot take preemptive actions to avoid these delays.

For these reasons, the FCC should on reconsideration confirm that the agency will entertain waivers of penalties for missed clearing deadlines that are the result of COVID-19 delays outside of satellite operators' control. Any such waiver could be predicated on the ability of the party seeking a waiver being able to provide specific information about the issue encountered, the options available, and how the circumstance requiring the waiver of a transition deadline affects the timing of accelerated relocation.⁵⁸

VI. CONCLUSION

The C-band transition is a complex undertaking. But at bottom, the transition must be grounded in a solid evaluation of the technical requirements that must be in place in order to prevent new terrestrial operations in adjacent spectrum from causing harmful interference into remaining satellite operations post-transition. It makes no sense for a complex process purportedly designed to ensure continuity of satellite operations in a reduced portion of the spectrum to ultimately fail to protect the quality and reliability of the remaining satellite services post-transition. Intelsat therefore urges the Commission to act swiftly in its review of the

⁵⁸ The FCC should broaden the existing notification process discussed in the Report and Order beyond delays affecting work at individual earth stations when encountering certain unexpected delays beyond the earth stations' control to include delays occasioned by the effects of COVID-19 shutdowns to supply chains or labor markets. *See* Report and Order, para. 294, Appendix A (amended 47 C.F.R. § 27.1412(b)(3)(i)).

technical rules adopted in the Report and Order that are problematic and modify them to ensure that space station operators and incumbent earth station operators are able to continue to provide Americans with service that is substantially similar in quality and reliability to what they experience currently.

Respectfully submitted,



Intelsat License LLC

Laura H. Phillips
Qiusi Y. Newcom
Faegre Drinker Biddle & Reath LLP
1500 K Street NW Suite 1100
Washington, D.C. 20005
202-842-8800
laura.phillips@faegredrinker.com
Counsel for Intelsat License LLC

Michelle V. Bryan
Executive Vice President, General Counsel and Chief Administrative Officer
Susan H. Crandall
Associate General Counsel
Intelsat US LLC
7900 Tysons One Place
McLean, VA 22102-5972

May 26, 2020

APPENDIX A



Feasibility Assessment of FCC's Narrowband C-band Filter Requirements

Prepared by Alga Microwave

May 22, 2020

Introduction

Alga Microwave Inc. ("Alga") was established in 2003 as an engineering and manufacturing company for telecommunications components used in both satellite and wireless broadcast systems. Alga and its division, mitecVSAT, are leading suppliers of radio frequency and microwave solid state power amplifiers, transmitters, transceivers, and passive components. The company produces active components for use in the L, S, C, X, Ku, and Ka bands (2 to 31 GHz), with power ranges of 5 to 12000 Watts. The company also produces passive components, with many cavity filters that span frequency ranges from 500 MHz to 100 GHz.

Alga is a preferred supplier for Ericsson AB Sweden, and in that capacity Alga has produced over 700,000 filters over the last 14 years. This represents over 40% of Ericsson's global demand for point-to-point radios and 100% of long-haul radio diplexers covering frequencies from 5 to 90 GHz.

This technical analysis was performed by Patrice Bourbonnais and Michael Perelshtein, whose professional technical backgrounds are provided at the end of this document.

Description of Assessment

In this document, Alga assessed whether a narrowband C-band filter design is capable of meeting the FCC filter requirements proposed for Telemetry, Tracking, and Command ("TT&C") antennas in the FCC's recently adopted order in the C-band Flexible User proceeding.¹ **As explained below, we conclude that no such narrowband filter design would be capable of functioning in a manner that could meet the FCC's recently adopted C-band filter requirements.** As a result, unless the FCC modifies its TT&C filter requirements, TT&C carriers will not be protected against harmful interference and satellite safety will be put at risk.

Narrowband Filter Assessment

¹ See Expanding Flexible Use of the 3.7 to 4.2 GHz Band, Report and Order and Order of Proposed Modification, GN Docket No. 18-122, FCC 20-22 (rel. Mar. 3, 2020) ("C-Band R&O"). The filter requirements are set forth in paragraphs 388 through 389 of the C-Band R&O and in FCC rule section 27.1423, Protection of Incumbent Operations.

*16715 Hymus Boulevard, Kirkland, Quebec
H9H 5M8 Canada
Phone: +1-514-694-8666 Fax: +1-514-694-3254*

In this document, we analyze whether any narrowband filter design would be capable of meeting the FCC filter requirements recently adopted for TT&C. For purposes of this analysis, we take into consideration the actual TT&C frequencies in use on Intelsat satellites that rely on TT&C antennas Intelsat uses within the contiguous United States.

Figure 1 below shows the frequency allocation of the most potentially impacted operational TT&C frequencies of the Intelsat satellites falling inside the 3700-4000 MHz spectrum to be cleared for flexible use operations. These TT&C frequencies range between 3704 MHz to 3710 MHz (lower band) and between 3947 MHz to 3953 MHz (upper band). The nominal emission bandwidth for each of the TT&C signals is about 500 kHz.

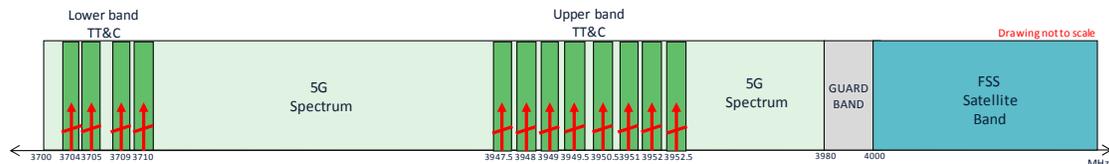


Figure 1 Intelsat TT&C signals.

In the C-band R&O, the FCC adopted the following filter specifications for TT&C (see paragraph 389):

Because the bandwidth of the TT&C emission can vary, this filter will have to be custom fit for each earth station. The quality should be just as robust, providing a minimum of 60 dB of rejection. The frequency at which the TT&C filter must meet this 60 dB of rejection will vary with the bandwidth. We expect that the filter should meet 60 dB of rejection for all frequencies removed from the TT&C's center frequency by more than 150% of the TT&C's emission bandwidth, both above and below the TT&C channel. Further, the filter should provide 70 dB of rejection for all frequencies removed from the TT&C's center frequency by more than 250% of the TT&C's emission bandwidth, both above and below.

Key requirements of these filter specifications as applied to the Intelsat satellites would be:

- Center frequency as provided in Figure 1
- Passband bandwidth of about 0.5 MHz²
- 60 dB rejection of about +/- 0.75 MHz
- 70 dB rejection of about +/- 1.25 MHz

Figure 2 graphically illustrates the FCC filter specifications based on TT&C center frequency of 3950 MHz with 500 kHz emission bandwidth.

² The TT&C emission bandwidth varies, but the nominal emission bandwidth is 500 kHz, as noted above.

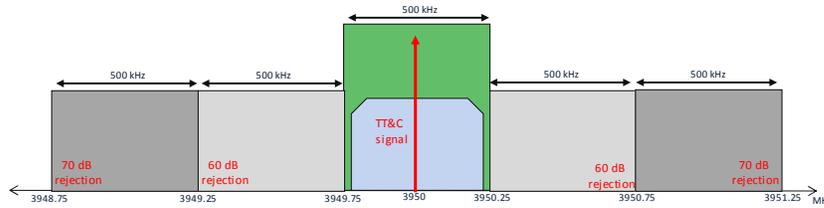


Figure 2 TT&C Filter Requirement based on FCC C-band R&O

As a point of reference, Table 1 compares the bandwidth required for the passband, guard-band to achieve 60 dB rejection, and guard-band to achieve 70 dB rejection for the TT&C carriers and post-transition FSS transponders, respectively. Notwithstanding the narrow TT&C passband, the TT&C guard-bands required to achieve 60 dB and 70 dB rejection are about two orders of magnitude lower than FSS guard-band. Table 1 illustrates the challenges of the FCC's new TT&C filter requirement as compared to the Alga designed, built, and tested 200-MHz passband FSS filter to be employed in every eligible antenna to ensure protection of FSS operations post-transition. In the next section, Alga's filter simulation results using this as the baseline are demonstrated.

Table 1: FSS and TT&C Guard-band Comparison

	FSS (MHz)	TT&C (MHz)
Passband	200	0.5
Guard-band to achieve 60-dB rejection	20	0.5
Guard-band to achieve 70-dB rejection	100	1

Simulation and Analysis

Alga evaluated the FCC's TT&C filter mask requirements and concluded that a narrowband filter as specified in the C-band R&O is unworkable for various reasons. First, the narrowband filter requirements have a low percentage bandwidth: $0.5 \text{ MHz} / 3950 \text{ MHz} = 0.000127$. Percentage bandwidth is defined as the ratio of the passband bandwidth to center frequency. In such a circumstance, the frequency drift performance of a filter design becomes very important, since the low percent bandwidth displays a large sensitivity to drift as a function of ambient temperature as shown in Table 2. As the passband bandwidth is relatively small, the center frequency can be expected to potentially drift outside the passband. Table 2 illustrates a cavity filter built of various materials that was simulated for frequency drift at 3950 MHz over $-40 \text{ }^\circ\text{C}$ to $+70 \text{ }^\circ\text{C}$, and the results are set forth below:

Table 2: Cavity Filter Drift for Various Materials

Material	Thermal expansion (ppm/ $^\circ\text{C}$)	Drift at $-40 \text{ }^\circ\text{C}$	Drift at $70 \text{ }^\circ\text{C}$
Invar 36	2.0	+0.49 MHz	-0.41 MHz
Copper	16.4	+3.84 MHz	-3.20 MHz

Aluminum (6061)	22.9	+5.35 MHz	-4.46 MHz
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As demonstrated above, even with consistent use of a temperature stable material such as Invar 36, the center frequency can drift well beyond the passband requirements.

Secondly, the tight manufacturing tolerances for the FCC's filter specifications result in large frequency drift that cannot be compensated. Specifically, the FCC's filter specifications will lead to tighter tolerances that correspond to a frequency drift of +/- 0.8 MHz.

Thirdly, the FCC's TT&C filter mask requirement is not able to be implemented for the size of the guard-band the agency adopted. In order to meet the rejection requirements and keep insertion loss within a 1 dB, a guard-band of 20 MHz on each side of the emission bandwidth (40 MHz in total) is necessary for each individual TT&C carrier to achieve 60 dB rejection, which is far beyond the 0.5 MHz guard-band recently adopted by the FCC.

Conclusion and Recommendation

This paper demonstrates that a cavity filter cannot be designed to meet the FCC's recently adopted narrowband filter requirements to protect TT&C carriers from interference from co-channel flexible use operations. A guard-band of 20 MHz on each side of the TT&C carriers' emission bandwidth (40 MHz in total) is required to ensure the rejection levels mandated in the C-band R&O are realized.

* * *



Michael Perelshtein

President

Alga Microwave inc.

Alga Microwave Inc. (Alga) design and manufacturer of quality, cost-effective active and passive RF/Microwave components and systems, and is a preferred supplier of key components to a Tier 1 Global Telecom Equipment provider.

Michael Perelshtein, (Founder)

Number of years at Alga Microwave: 17

Patrice Bourbonnais, Principal Designer

Number of years at Alga Microwave: 17

Mr. Perelshtein and Mr. Bourbonnais have published many conference/transactions papers and patents, some examples are included here:

- U. Rosenberg, A. Bradt, **M. Perelshtein** and **P. Bourbonnais**, “Extreme broadband waveguide diplexer design for high performance antenna feed systems,” in Proc. 2010 European Microwave Conference (EuMC), Sept 2010, pp. 1249–1252
- U. Rosenberg, A. Bradt, **M. Perelshtein** and **P. Bourbonnais**, “Broadband ortho-mode transducer for high performance modular feed systems,” in Proc. 40th Eur. Microwave Conf. (EuMC), Sep. 2010, pp. 807–810.
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Company address:

Alga Microwave Inc.

16715 Hymus Blvd.

Kirkland, QC H9H 5M8 Canada